Ergonomics and occupational health in sugar industry of Pakistan

BY

Engr. M. Adeel Ashraf

M.Sc. (Hons) Agri. Engg.

Department of Farm Machinery & Power
Faculty of Agri. Engg. & Technology

Introduction

- Ergonomics is a science of designing user interaction with equipment and workplaces to fit the user.
- The introduction of hazardous technologies in industry and agriculture has resulted in high accident rates, occupational diseases, and unhealthy working environments.
- The injuries and occupational health disorders are very high in Pakistan because a large community of workers is routinely exposed of different kinds of hazardous chemicals.
- most of the workers are uneducated and unconscious of protective measures

Introduction (Cont'd….)

- No data are available about occupational health and safety (OHS) in Pakistan because the majority cases of injuries of workers have not been reported to the Labor Department
- 75000 labor force existed in Pakistan Sugar Industry
- 40% labor force suffered different kind of disorders due to result of their occupation
- This figure vary from minor injuries to more severe and permanent and fatal injury
- The purpose of occupational health and safety (OHS) to secure the workers health and to identify, assess and prevent health disorder at the industrial level

Objectives of the Study

- To assess and quantify the safety measures taken at different sections of sugar mills regarding ergonomics and occupational health.
- To point out critical shortfalls in the existing design of machinery and suggest the proper modification of the existing design to reduce accidents at different sections of sugar plant to be incorporated in industries work force by-laws
- To develop appropriate training and education program for operators in order to minimize occupational health disorders.

Material and Methods

- The proposed research work was conducted in different Sugar Mills of Pakistan. All the necessary information regarding machinery, equipment, working environment and health condition of the workers at different sections was collected through questionnaire.
- A comprehensive questionnaire was prepared to collect data and all the necessary information related ergonomics and occupational health in different sugar mills of Pakistan.
- In sugar mills data were collected in Cane handling units, Mills house, Process house, Boiler house, Power house and Workshop.

Cane Sugar industry

- This study was planned to indentify all the risk factors related to machinery and working environment and suggestions to minimize these risk factors in different sugar industries of Pakistan. Sugar industry is basically seasonal in nature and operates only for 120 to 150 days in a year (mid November to mid April)

Cane handling and Mill house

- Mill house consists of many uncovered machine parts like rollers of mills, different chains and driving units. Moreover, the oil deposition on the floor beneath the mills causes slippery problems during working hours. Most of the work is carried out without stopping of mills which causes accidents in most of the sugar mills. Planned ergonomic studies can play a vital role in reducing the accident at this section

Boiler house

- This house is the most sensitive section in a sugar mills that needs frequent monitoring. It has been observed from study that the lack of carelessness at this section may cause the severe damage which resulting a number of death and injuries. Out of all the houses, this section needs more vigilance and ergonomic studies to prevent from severe mishap. Annual maintenance and cleaning of boiler system is necessary to keep the system at peak efficiency

Process house

- This is the biggest house in a sugar mills where different kinds of machine parts are available. Most of the accidents in process house due to the steam and hot water leakage. Moreover, the dismantling and breakage of centrifugal machines cause severe damage of property and health. This section needs proper preventive maintenance to avoid big risk factor

Power house

- The steam produced in boiler house is delivered to the power house where this steam is used by steam turbines to produce electricity. This section comprises of prime mover and it is the most sophisticated part of sugar mill. Preventive maintenance is required to run the turbines and generator at safe working level. Lubricant dropped on the floor which produce the slippery is the reason of injury of workers.

Assessment of working environment in sugar mills

- In order to assess the safe working environment, pH meter, Carbon Monoxide detector, Noise meter, Oxygen (O_2) detector and Hardness Test Kit had been purchased and were used
- At present, most of the workers have not access to the clean drinking water. In order to assess the quality of water, a pH meter was used
- Carbon monoxide (CO) detector was used to detect the presence of carbon monoxide gas (CO) to modify the boiler for minimizing its bad effects
- A sound meter was used to measure noise and sound levels in a specified manner. The impact of noise may cause permanent hearing loss due to the exposure to noise levels exceeding 90 dB (where dB is the noise measurement unit)
- Oxygen (O_2) is an electronic device that measures the proportion of oxygen (O2) gas by volume in air
- Hard water is water that has high mineral content in contrast with soft water. Hard water has high concentrations of Ca2+ and Mg2+ ions. The hardness level as mg/l (ppm) calcium carbonate was measured by hardness test kit

Occupational Health and Safety concern in industry

- It is a cross disciplinary area concerned with the safety, health and welfare of people engaged in work or employment
- The main purpose of all occupational health and safety programs is to promote a safe working environment
- On the other hand, it may also protect co-workers, family members, workers, customers, suppliers, nearby communities, and other members of the public who are affected by the workplace environment
- It is essential for every industrial manager to design workplace, installations, equipment, tools, raw materials, byproducts, and the degree and sophistication of employees training

Results and Discussion

- The proposed research work was conducted during the cane crushing season 2010-11 in different sugar industries of Pakistan. All the necessary information regarding machinery, equipment, working environment and health condition of the workers at different sections was collected through questionnaire

Injuries of Workers in Sugar Industries of Pakistan

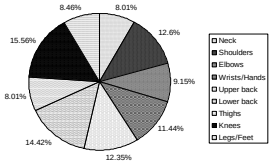
- Keeping in view the importance of the workers as the real backbone of industry, it was planned to conduct interviews of injured victims to record their injuries faced during working in sugar industries. A questionnaire was filled which consisted of injured victim's age, injury on body regions, machines parts causing injuries and reasons of injuries of workers at different sections of sugar mills

Sugar Mill Sections	No. of victims	Age limit (years)	Injuries on Body part	Machine parts Causing injury	Cause of injury of workers
Cane Handling Unit	11	16-25	Right hand elbow, Left and Right hand fingers and Face injured etc.	Belt and Pulley; broken Guide Pulley; leakage of lubricant from Turbine	Safety equipments not provided to worker
	8	26-35			
	8	36-45			
	3	46-55			
	2	>55			
Mill House	13	16-25	Right hand elbow, Left and Right hand fingers, Right hand arm etc.	Cane Cutter, Cane Leveler, Auxiliary Cane carrier, Motor Belt and Pulley	Safety equipments not provided to worker, no proper awareness and education provided about machinery operation
	8	26-35			
	9	36-45			
	6	46-55			
	4	>55			
Boiler House	19	16-25	Left and Right hand, Legs injured face problem etc.	Chain broken, Boiler tubes leakage, breakage Belt and Pulley; Foundation Bolts broken	Safety equipments not provided to worker, lack of preventive maintenance of the equipments at boilers
	11	26-35			
	9	36-45			
	8	46-55			
	3	>55			
Process House	8	16-25	Left and Right hand, Legs and Face injured etc.	Vacuum Filter, Centrifugal Machine and tubes leakages etc.	Safety equipments not provided to worker, excessive vibration and noise of the equipments at process house
	4	26-35			
	3	36-45			
	2	46-55			
	1	>55			
Power House	4	16-25	Human body injured etc.	Turbines Plates damage, Electric shock etc.	Safety equipments not provided to worker, lack of knowledge about precautions at power house
	2	26-35			
	1	36-45			
	1	46-55			
	0	>55			
Workshop	20	16-25	Left and Right hand injured, Legs and Face injured etc.	Lathe, Drill, Milling and Grinding Machines etc.	Safety equipments not provided to worker, no proper training and education etc.
	8	26-35			
	5	36-45			
	4	46-55			
	1	>55			

Interviews of injured victims

Musculoskeletal disorders (MSDs) symptoms in workers in Sugar Mills

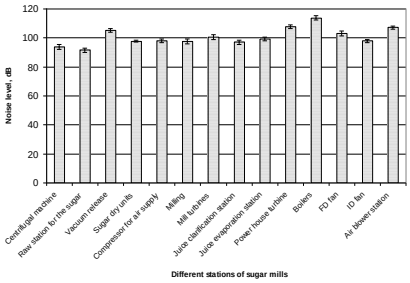
- During survey of sugar industries of Pakistan it was conducted that 437 workers were suffering from musculoskeletal disorders symptoms in different body regions.
- The workers' knees, lower back, shoulders, and upper back were most commonly affected. The reasons of high musculoskeletal disorders symptoms in different body regions of workers were Poor working conditions and the absence of an effective work injury prevention program, heavy load lifting, lowering, carrying, pulling, and pushing in sugar mills.



Noise measurement at different Stations of Sugar Mills

- Noise is defined as unwanted sound. It is considered one of the most widespread environmental issues all over the world
- Sugar industry is one of the agro base industries in Pakistan where heavy machines are operated by workers and huge levels of noise are produced
- Environmental Protection Agency (EPA) Lahore set noise standards for the industrial workers so that they can use safety equipments properly
- At 85 dB the EPA standard for safe sound is 45 minutes while at 88 dB the EPA standard for safe sound is 23 minutes. EPA regards 91 dB as unsafe for any length of time over 11 minutes
- It had been observed in sugar mills that each station in sugar mills was producing high noise level than the safe limit of sound as described by EPA

Noise measurement at different Stations of Sugar Mills

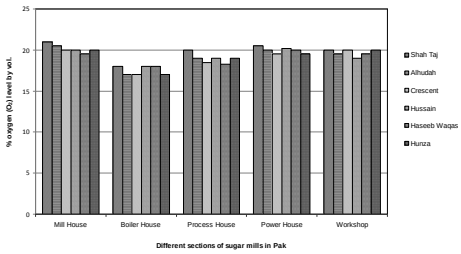


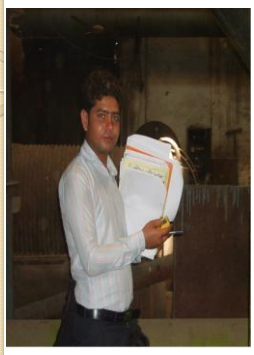
Determination of Water Parameters in Sugar Mills

- Drinking water quality is the major priority for health. For this purpose, hardness test kit and pH meter were used to analyze the water quality at the site.
- The value of hard water lies in the range of 120 to 180. So this hard water is not good for drinking and industrial utilization.
- The analysis was showed that some of the mills have pH out of the permissible range which ultimately affects the health of the workers adversely.
- Hardness of drinking water of most of the mills was giving the alarming figures. High hardness levels of water were causing the kidney and other stomach problems. The weak health of the workers was the clear indication of bad water quality for drinking purposes.

Parameter	Sugar Industry					
	Shah Taj	Alhudah	Crescent	Hussain	Haseeb Waqas	Hunza
pH value	7.2	7.95	7.79	8.3	9.2	8.9
CaCo3 (ppm)	132	159	153	159	162	156

Determination of Oxygen level at different sections of Sugar Mills

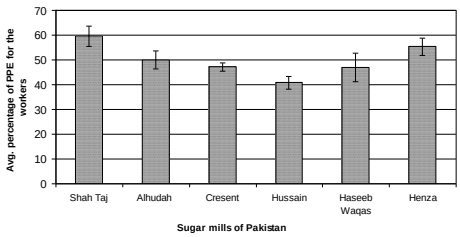




Determination of Safety Equipments for workers

- During visiting of sugar mills, the data was collected about safety equipments for workers.
- It was observed that most of the workers in different sugar mills in Pakistan were not equipped with safety measures due to which many workers get injuries.
- It was observed from figure that the average percentage of personal protective equipment (PPE) provided to the workers at different sections was varied from 40.8 to 59.6 in Hussain sugar mill to Shah taj sugar mill.
- Statistical analysis was carried out and the values of standard errors were found to vary from 1.714 to 5.744. These values were found in low range showing that less than 50% workers were equipped with safety measures at different sections of sugar mills.
- It was observed that no attention was being paid on this very important issue in most sugar mills in Pakistan. Number of injuries of workers can be reduced by providing appropriate safety equipments to the workers

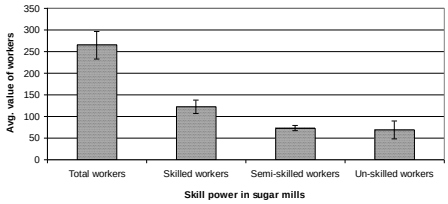
Determination of Safety Equipments for workers



Determination of skill-power of the workers in Sugar Mills

- It had seen in sugar mills that most of the workers were un-trained at the time of joining the mills, so they get injuries during working hours.
- During visiting of sugar mills, the data was collected about skilled, semi skilled and un-skilled workers.
- Skill workers had completed their training and education courses while semi skill workers were going through a process of training and education programs. Un- skill workers had no training and education to operate the machines in sugar mills.
- It was observed in sugar mills that education and training programs were not running properly for the workers before starting of cane crushing seasons.
- It was observed from figure that the average 265 workers worked in each sugar mill of Pakistan in which 123 workers were fully trained, 73 workers were semi-skilled and 69 workers had no training and education about their profession. Statistical analysis was carried out and the values of standard errors were found 31.52 for total workers, 15.75 for skilled workers, 6.31 for semi-skilled and 19.92 for un-skilled workers.

Determination of skill-power of the workers in Sugar Mills



Examining Critical shortfalls in the design of machinery and suggestion to overcome the shortfalls at different sections of Sugar Mills

Equipments at Main section/area	Quantity	Shortfall in the existing design with reference to ergonomics	Suggestion to overcome the shortfall
Truck tippler	03	40° Angle limit not properly manage	Sensor system should be equipped with limit switch to avoid tilting of trollies
Stopper	03	Stopper broken, hydraulic pressure leakage	The structure should be reinforced, High pressure wire-braided rubber hose to be proved
Feeding table Carrier	01	Chain broken, safety guards broken, main shaft broken and sprocket gear teeth wash	High quality material to be used, ultrasonic checking of the shaft, Need of heavy duty reduction gears
Main cane carrier	01	Gears teeth wash, belts and pulleys broken, reduction gear box and coupling broken	Proper material and profiles of the pinion to be casted, proper alignment to be done
Cane leveler	02	Drag roller chain broken, coupling bushes broken, protection covers were not provided	Master pins must be of high quality and these should be reinforced, Protection cover to be provided to avoid accidents
Cane cutter	03	Knives broken, sprocket gears teeth wash, bearing and bushes broken	Disk type cutter to be provided, proper alignment to be done
Cane shredder	03	Gears teeth broken, bearing heat up, oil lubricant leakage, foundation bolts corroded etc.	Proper alignment to be done, Use of high carbon casted bearings and bolts, leaky points to be welded
Cane elevator	01	Foundation bolts broken, yoke chain broken, head and tail shaft misaligned	Proper alignment to be don, High carbon casted yoke chain to be provided
Mills	05	Pressure feeder, mill feeder and mill discharge rollers teeth broken, trash plate broken, Scraper plates broken and pressure chute broken	Proper material and profiles of the rollers to be casted, high quality material is to be used and ultrasonic checking to be done before running the mills

Main bagasse carrier	01	Gears teeth broken, chain, pins and bushes broken; plumber block bearings loosed, coupling broken etc.	High quality drag roller chain to be provided, proper alignment of the driving gear, standby driving unit to be provided to avoid the mishap during stoppage
Boiler furnace	03	Bars broken, side plates broken, leakage of Pneumatic pressum, boiler tubes blast etc.	Pneumatic system to be rectified, side plates to be replaced and ultrasonic checking to be done
Forced draft fan	01	Foundation bolts broken, bearings and shaft broken, motor heat up due to overload	Proper alignment to be done, and high quality material is to be used
Induced draft fan	01	Rotor wear and tear, fan blades broken, bearings and shaft broken, belt and pulley broken	Proper alignment to be done, high quality material is to be used and ultrasonic checking to be done before running
Defection tank	01	Plates damaged, gears bearing and bushes broken	Reinforcement of the plates, proper alignment to be done
Clarifier	01	Tank sheet leaky, foundation bolts broken, tank sheet corroded	Hydraulic tests to be conducted, old sheets to be replaced by new ones
Evaporator section	01	The tubes were leaky, glasses joint broken	hydraulic tests to be carried out to locate the leaky tubes high quality glass to be used
Pan station	01	Manifold valves were leaky, shower problem, vacuum break up	Good quality valves to be provided, hydraulic tests to be carried out to locate the leaky points to meet the vacuum break problem
Centrifugal station	01	Shaft of the prime mover broken, motor belt and pulley broken, sprocket gear teeth wash and excessive vibration	Dynamic balance of the centrifugal station to be checked out, high quality V-belts to be provided and proper casting of V-belt pulleys to be done.
Turbines	03	Roller and Bearing broken, walls joint broken, pipe lines blast, governor control misaligned	Note: There is no compromise on turbine section. If anything is found abnormal, it must be checked immediately

Training and Education Program for Operators/workers

- A safe and healthy work environment is the basic right of every worker. Training and education of all permanent and intermittent workers, including managers and supervisors can be provided through a brief on-site safety meeting.
- All industry managers should be arranged multimedia presentations for workers about machinery use and protection equipments that should be used before starting their jobs.
- All industry managers should be provided information for the safe use of machinery and chemicals in the appropriate language (local language).
- All industry managers should be provided noise standards and protection equipments- this simple step may go a long way in reducing the toll of accidents and diseases at the work place.
- The recruitments at the boiler section should be at least 1st class or 2nd class boiler engineers recognized by the Punjab Board of Boiler.
- Provided sufficient clearance around and between machines to allow for safe operations, set up and servicing, material handling and waste removal.

- Manager responsibility

Worker Training and education Record

Worker name	Training dates	Type of training	Name of trainers

CONCLUSIONS

- The injury of workers in sugar mills resulted in lack of safety measures, no proper training and education program, safety covers were not provided to the vibrating machines, excessive noise and vibration of machines parts, poor ventilation and lighting during working hours, there was no facility for the workers to drink clean and pour water, lubricant dropped on the passage of the workers, there was no facility of first-aid and preventive maintenance staff was no appointed at the sensitive sections of sugar mills.
- In sugar mills of Pakistan workers injuries can be reduced by solving all the problems faced by workers during working position which can also increased the production of industries.

THANKS